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No. 75—1916.

British Engineering Standards Association.

(*Incorporated 1918.*)

FORMED IN 1901 AS THE ENGINEERING STANDARDS COMMITTEE

BY

THE INSTITUTION OF CIVIL ENGINEERS.
THE INSTITUTION OF MECHANICAL ENGINEERS.
THE INSTITUTION OF NAVAL ARCHITECTS.
THE IRON AND STEEL INSTITUTE.
THE INSTITUTION OF ELECTRICAL ENGINEERS.

UNIVERSITY OF TORONTO
1920
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BRITISH STANDARD SPECIFICATIONS FOR WROUGHT STEELS FOR AUTOMOBILES.

LONDON:
PUBLISHED FOR THE ASSOCIATION BY CROSBY LOCKWOOD & SON,
7, STATIONERS' HALL COURT, LUDGATE HILL, E.C. 4; AND 5, BROADWAY, WESTMINSTER S.W. 1,
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June, 1918.

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BRITISH ENGINEERING STANDARDS ASSOCIATION.

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MR. C. LE MAISTRE (*Secretary*).

MR. CHARLES DRESSER (*Assistant Secretary*).

* Succeeded the late SIR JOHN WOLFE BARRY, K.C.B., February, 1918.

BRITISH ENGINEERING STANDARDS ASSOCIATION.

The following are Lists of Members of the Sectional Committee on Automobile Parts and of Sub-Committee **F** on Automobile Parts which is dealing with the Standardisation of Steels, Cast Iron, Aluminium, and Bearing Metals.

SECTIONAL COMMITTEE ON AUTOMOBILE PARTS.

May, 1916.

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War Office, Major T. M. Hutchinson, A.S.C.; Capt. A. L. C. Neame, R.E.; Mr. G. H. Roberts.
General Post Office, Mr. Charles Wheeler.
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Automobile Association and Motor Union, Mr. P. A. Sharman; Mr. A. B. E. Cheeseman.
Institution of Automobile Engineers, Mr. Basil H. Joy; Mr. L. A. Legros; Mr. L. H. Pomeroy.
Society of Motor Manufacturers and Traders, Ltd., Mr. T. C. Pullinger; Mr. H. C. Clark; Mr. A. A. Remington; Mr. T. H. Woollen.
Commercial Motor Users' Association, *Mr. George W. Watson.
Institute of British Carriage Manufacturers, Mr. Charles Holmes.
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* Succeeded Mr. B. Humphrey, February, 1916.

SUB-COMMITTEE F ON AUTOMOBILE PARTS. (STEELS, CAST IRON, ALUMINIUM, AND BEARING METALS).

May, 1916.

Chairman, COLONEL SIR H. C. L. HOLDEN, K.C.B., R.A.
Admiralty, Eng.-Captain Francis H. Lister, R.N.; Commander W. Briggs, R.N.
War Office, Major T. M. Hutchinson, A.S.C.; *Capt. M. J. H. Bruce, A.S.C.
Crown Agents for the Colonies, Mr. Ashton M. Heath.
National Physical Laboratory, Dr. R. T. Glazebrook, C.B.
Iron and Steel Institute, Mr. R. E. E. Spencer.
Institute of Metals, Prof. A. K. Huntingdon.
Royal Automobile Club, Mr. W. Worby Beaumont.
Institution of Automobile Engineers, Mr. L. H. Pomeroy.
Society of Motor Manufacturers and Traders, Ltd., Mr. Basil H. Joy; Mr. T. Thornycroft.
Commercial Motor Users' Association, †Mr. B. Humphrey.
Mr. Bertram Blount; Mr. J. Echevarri (*British Aluminium Co., Ltd.*); Mr. C. W. Findlay (*Glacier Anti-Friction Metal Co., Ltd.*); Mr. H. E. Hemmings (*Willans & Robinson, Ltd.*); Mr. J. Newton (*Billington & Newton, Ltd.*); Mr. Alex. Williamson (*Vickers, Ltd.*).

* Representing the War Office during Major Hutchinson's absence on service.
† Succeeded by Mr. George W. Watson, February, 1916.

PREFACE.

The Sectional Committee on Automobile Parts was appointed by the Main Committee at their meeting on July 18th, 1912, for the purpose of dealing with the various details in connection with the Standardisation of the Automobile Parts referred to the Committee by the Society of Motor Manufacturers and Traders Ltd. Eleven Sub-Committees have been formed under the Sectional Committee, upon which additional members having special knowledge of the matters to be dealt with by the various Sub-Committees have been co-opted.

In January, 1915, a Committee was appointed by the Institution of Automobile Engineers to prepare representative Specifications for Steels suitable for use in Automobile Construction with a view to their submission to and adoption by the Engineering Standards Committee as the British Standard Specifications for this class of material. The Institution Steels Committee, of which Mr. Pomeroy acted as Chairman, and Mr. Basil Joy, the Secretary of the Institution, officiated as Secretary, was constituted as follows :—

LIEUT.-COL. R. K. BAGNALL-WILD, R.E. (Aeronautical Inspection Dept., War Office).

MR. HY. BREARLEY.	*Steel Manufacturers.*
MR. J. H. S. DICKENSON (Vickers Ltd.).	
MR. D. FLATHER (W. T. Flather, Ltd.).	
*MR. P. B. HENSHAW (Kayser, Ellison & Co., Ltd.).	
DR. W. H. HATFIELD (Jno. Crowley & Sons, Ltd.).	*Manufacturers of Small Castings.*
MR. A. E. BERRIMAN (Daimler Co., Ltd.).	*Automobile Manufacturers.*
MR. L. COATALEN (Sunbeam Motor Car Co., Ltd.).	
MR. L. H. POMEROY (Vauxhall Motors Ltd.).	
MR. A. A. REMINGTON (Wolseley Motors, Ltd.).	
MR. C. A. CLARKE (Thos. Smith's Stamping Works).	*Stampers.*
MR. W. A. LANDELLS (Deritend Stamping Co.).	
MR. A. STUBBS (Smethwick Stamping Co.).	
MR. C. F. H. TREDGOLD (Hughes-Johnson Stampings, Ltd.).	

The Specifications were transmitted by the Institution Steels Committee to the Engineering Standards Committee with the request that they be communicated to the principal makers of the steels dealt with for their criticisms. The comments received were considered in conjunction with the Specifications at a joint meeting of the Engineering Standards Automobile Sub-Committee **F** and the Institution Steels Committee.

* Succeeded Mr. H. Francis (Kayser, Ellison & Co., Ltd.), December, 1915.

The question of including some form of impact test in the Standard Specifications was considered, and it was felt that though some such test would ultimately be of great value, the present want of knowledge and experience of the subject and the diverse views as to how the test should be carried out make it undesirable to include such tests in the Specifications for the present.

The Committee are aware that other Alloy Steels than those dealt with are in use at the present time, but desire to point out that the issue of Standard Specifications is not intended in any way to preclude the employment of these, but merely to provide such a choice of steels of definite composition as will meet the present general requirements of Automobile construction.

In June, 1915, a Research Committee was formed jointly by the Institution of Automobile Engineers and the Society of Motor Manufacturers and Traders Ltd., and this Committee is proceeding with further investigations into the various physical properties of the Standard Automobile Steels dealt with in this Report and of factors governing testing procedure in connection therewith.

This Report was adopted by the Sectional Committee on Automobile Parts at their meeting on February 18th, 1916.

This Report was approved by the Main Committee at their meeting on March 24th, 1916.

H. C. L. HOLDEN,

Chairman of Sectional Committee on Automobile Parts.

Note.—*The Association desires to call attention to the fact that these Specifications are intended to include the technical provisions necessary for the supply of the material herein referred to, but do not purport to include all the necessary provisions of a Contract.*

BRITISH STANDARD SPECIFICATIONS FOR WROUGHT STEELS FOR AUTOMOBILES.

DEFINITIONS OF TERMS USED IN THESE SPECIFICATIONS.

Normalising.

1. Normalising means heating a steel (however previously treated) to a temperature exceeding its upper critical range and allowing it to cool freely in the air. The temperature shall be maintained for about 15 minutes and shall not exceed the upper limit of the critical range by more than 50° Centigrade.

Annealing.

2. Annealing means re-heating followed by slow cooling. Its purposes may be :—

(*a*) To remove internal stresses or to induce softness in which case the maximum temperature may be arbitrarily chosen.

(*b*) To refine the crystalline structure in addition to the above (*a*), in which case the temperature used must exceed the upper critical range as in normalising.

Hardening.

3. Hardening means heating a steel to its normalising temperature and cooling more or less rapidly in a suitable medium, *e.g.*, Water, Oil and Air.

Tempering.

4. Tempering means heating a steel (however previously hardened) to a temperature not exceeding its carbon change point with the object of reducing the hardness or increasing the toughness to a greater or less degree. This operation may usually be followed either by slow cooling or water-quenching without materially affecting the final result.

Cementing.

5. Cementing means heating a steel above its normalising temperature in a medium which will increase the carbon content.

Core.

6. The Core of a case-hardened bar is the interior portion of the bar which is substantially unaffected in composition by the cementing process.

Refining.

7. Refining means re-heating a steel to its normalising temperature and is usually followed by quenching.

Tensile Breaking Strength.

8. The Tensile Breaking Strength is the greatest load sustained at any time by the loaded test piece, expressed in tons per square inch on the original area of the test piece.

Yield Ratio.

9. The Yield Ratio is the Ratio between the yield stress* and the tensile breaking strength.

Elongation.

10. The Elongation per cent. is the difference between the original and the fractured gauge length expressed as a percentage of the original gauge length of the test piece.

Reduction of Area.

11. The Reduction of Area per cent. is the difference between the original and fractured areas expressed as a percentage of the original area of the test piece.

GENERAL CLAUSES.

Quality of Material and Tests to be complied with.

12. The Wrought Steels dealt with in these Specifications shall comply in all respects with the requirements herein laid down, and may be subjected to both the chemical analysis and the check tests, unless it is specified in the enquiry that the check tests only will be applied.

Tests by Chemical Analysis.

13. The Maker shall supply at his own expense an analysis of the steel when required so to do by the Purchaser or by the Engineer,† but samples may also be taken from the finished bars by the Purchaser or by the Engineer or Inspector‡ and at the

---

* The Yield Stress (or Yield Point) shall for the purpose of these Specifications be the load per square inch, at which a distinctly visible increase occurs in the distance between the gauge points on the test piece, observed by using dividers; or at which when the load is increased at a moderately fast rate there is a distinct drop of the testing machine lever, or, in hydraulic machines, of the gauge finger.

† The word "Engineer" throughout these Specifications shall mean the Engineer or Engineers supervising or acting as Engineer or Engineers for the Purchaser.

‡ The word "Inspector" throughout these Specifications shall mean any person expressly authorised in writing by the Engineer (or by the Purchaser) to perform the duties herein referred to or any of them.

expense of the Purchaser may be subjected to complete analysis by a metallurgist appointed by him.

Heat Treatment of Samples.

14. The samples selected for the check tests shall, before the test pieces are machined therefrom, be subjected to the simple form of heat treatment specified for the check tests in order to ensure accurate comparison of results.

Note.—The heat treatment specified is not necessarily an appropriate one for the finished article.

Size of Sample.

15. Whenever practicable the size of the sample selected for the check tests shall be at the time of heat treatment $1\frac{1}{8}$ inches diameter. For bars having diameters or sides above $1\frac{1}{8}$ inches the sample may, at the option of the Maker, be taken from the position shown in the sketches. Bars under $1\frac{1}{8}$ inches shall be heat-treated the full size as rolled.

Size of Test Piece.

16. The tensile breaking strength, yield ratio, elongation and reduction of area of the steel shall be determined from Standard Test Piece **C** (See Appendix, page 23).

Where unavoidably the sample is too small to allow of the Standard Test Piece **C** being prepared, the smaller dimensions chosen shall be such that the ratio $\frac{\text{gauge length}}{\sqrt{\text{area}}} = 4$.

Number of Tensile Tests.

17. Unless otherwise specified, the Purchaser, the Engineer or the Inspector may select one bar from every batch of fifty or part thereof. One tensile test shall be made from each bar selected as above.

Brinell Test.

18. The Brinell Hardness number shall be ascertained for each sample selected for testing.

The Brinell test shall be made on a clean surface with a 10 mm. diameter ball and a pressure of 3,000 kilogrammes maintained for not less than 15 seconds.

The Brinell numeral mentioned in the Specifications is for reference only and is not to be regarded as part of the check test.

Maker's Test at his Works.

19. All material required for testing shall be supplied by the Maker free of charge, and all test pieces shall be prepared by him

and tested at his works and at his cost and (if the Purchaser or Engineer so desire) in the presence of the Purchaser or of the Engineer or Inspector. If the maker fails to prepare properly the test pieces for testing or to test the steel properly at his works in the manner herein provided, the Purchaser or the Engineer may, at the Maker's cost, have the test pieces prepared for testing and the steel tested elsewhere.

Additional Tests before Rejection.

20. Should a tensile test piece break outside the middle-half of its gauge length, the test may, at the Maker's option, be discarded, and another test be made of the same bar. In all other cases should any of the tensile test pieces first selected not fulfil the tests applicable to the description of steel to be tested, two additional tensile test pieces may be taken, and should either of them fail to fulfil such tests, all the bars which the tensile test pieces represent may be rejected. The additional tensile tests shall be carried out in the same manner in all respects as the tensile tests hereinbefore required to be made in the first instance.

Inspection.

21. The Purchaser, the Engineer and the Inspector shall be afforded reasonable facilities to inspect the manufacture of the steel.

Painting.

22. All the consignments of steel ordered to these Specifications shall, before delivery, have each piece painted from end to end with the specified colour or colours. The paint shall be applied over not less than one side in the case of bars having flat sides and over not less than one-quarter of the circumference in the case of round bars.

When two colours are specified they shall be applied diagonally in stripes about 6 inches wide.

Arbitration.

23. In case any dispute shall arise between the parties to any contract in which this Specification is in whole or part incorporated as to whether any obligation, requirement, analysis or test of this Specification has been performed, carried out and/or complied with, then such dispute shall be referred to the arbitration of a person to be agreed upon between the parties or failing agreement to be appointed by the Chairman for the time being of the Engineering Standards Committee, provided always that if such dispute is within the terms of any other agreement to refer or submit to arbitration this Clause shall be of no effect.

SPECIFICATION
FOR
E.S.C. "10" CARBON CASEHARDENING STEEL.

1. Description.

The class of steel specified below shall be referred to as :—

E.S.C. "10" Carbon Casehardening Steel.

2. Chemical Composition.

Carbon	... ...	... 0·08 to 0·14	per cent.
Silicon...	... ...	...not over 0·20	,,
Manganese	... ...	... ,, 0·60	,,
Sulphur	... ...	... ,, 0·04	,,
Phosphorus	... ...	... ,, 0·04	,,

3. Check Test.

When normalised at 900° C. to 920° C., this steel shall pass in every particular the following check test :—

Tensile Breaking Strength	23 to 28	tons per sq. inch.	
Yield Ratio	not less than	50	per cent.
Elongation	,,	30	,,
Reduction of Area ...	,,	50	,,

The Brinell Hardness Number corresponding to the above should be approximately 92 to 112.

4. Painting before Delivery.

All consignments of the above steel shall, before delivery, be painted :—

Yellow.

SPECIFICATION
FOR
E.S.C. "15" CARBON CASEHARDENING STEEL.

1. Description.

The class of steel specified below shall be referred to as :—

E.S.C. "15" Carbon Casehardening Steel.

2. Chemical Composition.

Carbon	0·12 to 0·20 per cent.
Silicon	not over 0·20 ,,
Manganese	0·65 to 1·00 ,,
Sulphur	not over 0·07 ,,
Phosphorus	0·07 ,,

3. Check Test.

When normalised at 890° C. to 920° C., this steel shall pass in every particular the following check test :—

Tensile Breaking Strength	25 to 33 tons per sq. inch.
Yield Ratio	not less than 50 per cent.
Elongation	,, ,, ,, 28 ,,
Reduction of Area ...	,, ,, ,, 50 ,,

The Brinell Hardness Number corresponding to the above should be approximately 103 to 143.

4. Painting before Delivery.

All consignments of the above steel shall, before delivery, be painted :—

Yellow and Dark Brown in Stripes.

SPECIFICATION
FOR
E.S.C. 2 PER CENT. NICKEL CASEHARDENING STEEL.

1. Description.

The class of steel specified below shall be referred to as :—

E.S.C. 2 per cent. Nickel Casehardening Steel.

2. Chemical Composition.

Carbon	0·10 to 0·15 per cent.
Silicon	not over 0·30 ,,
Manganese	0·25 to 0·50 ,,
Sulphur	not over 0·05 ,,
Phosphorus	,, 0·05 ,,
Nickel	2·00 to 2·50 ,,

3. Check Test.

When normalised at 850° C. to 900° C. this steel shall pass in every particular the following check test :—

Tensile Breaking Strength	25 to 35 tons per sq. inch.
Yield Ratio	not less than 55 per cent.
Elongation	,, ,, 30 ,,
Reduction of Area ...	,, ,, 55 ,,

The Brinell Hardness Number corresponding to the above should be approximately 103 to 153.

4. Painting before Delivery.

All consignments of the above steel shall, before delivery, be painted :—

Yellow and Red in Stripes.

SPECIFICATION
FOR
E.S.C. 5 PER CENT. NICKEL CASEHARDENING STEEL.

1. Description.

The class of steel specified below shall be referred to as :—

E.S.C. 5 per cent. Nickel Casehardening Steel.

2. Chemical Composition.

Carbon	not over 0·15 per cent.
Silicon	,, 0·20 ,,
Manganese	,, 0·40 ,,
Sulphur	,, 0·05 ,,
Phosphorus	,, 0·05 ,,
Nickel	4·75 to 5·75 ,,

3. Check Test.

When normalised at 820° C. to 860° C., this steel shall pass in every particular the following check test :—

Tensile Breaking Strength	25 to 40 tons per sq. inch.
Yield Ratio	not less than 60 per cent.
Elongation	,, ,, 30 ,,
Reduction of Area ...	,, ,, 55 ,,

The Brinell Hardness Number corresponding to the above should be approximately 103 to 179.

4. Painting before Delivery.

All consignments of the above steel shall, before delivery, be painted :—

Yellow and Violet in Stripes.

SPECIFICATION
FOR
E.S.C. "20" CARBON STEEL.

1. Description.

The class of steel specified below shall be referred to as:—

E.S.C. "20" Carbon Steel.

2. Chemical Composition.

Carbon	0·15 to 0·25 per cent.
Silicon	not over 0·25 ,,
Manganese	0·40 to 0·85 ,,
Sulphur	not over 0·06 ,,
Phosphorus	,, 0·06 ,,

3. Check Test.

When normalised at 890° C. to 920° C., this steel shall pass in every particular the following check test:—

Tensile Breaking Strength	26 to 34 tons per sq. inch.
Yield Ratio	not less than 50 per cent.
Elongation	,, ,, 28 ,,
Reduction of Area ...	,, ,, 50 ,,

The Brinell Hardness Number corresponding to the above should be approximately 105 to 149.

4. Painting before Delivery.

All consignments of the above steel shall, before delivery, be painted:—

Light Brown.

SPECIFICATION
FOR
E.S.C. "35" CARBON STEEL.

1. Description.

The class of steel specified below shall be referred to as :—

E.S.C. "35" Carbon Steel.

2. Chemical Composition.

Carbon	... ...	... 0·30 to 0·40 per cent.
Silicon...	... ...	...not over 0·30 ,,
Manganese	... ...	... 0·50 to 0·85 ,,
Sulphur	... ...	...not over 0·06 ,,
Phosphorus	... ...	... ,, 0·06 ,,

3. Check Test.

When normalised at 850° C. to 880° C., this steel shall pass in every particular the following check test :—

Tensile Breaking Strength	30 to 40 tons per sq. inch.	
Yield Ratio	... ...	not less than 50 per cent.
Elongation	... ...	,, 25 ,,
Reduction of Area	...	,, 45 ,,

The Brinell Hardness Number corresponding to the above should be approximately 121 to 179.

4. Painting before Delivery.

All consignments of the above steel shall, before delivery, be painted :—

Dark Brown.

SPECIFICATION
FOR
E.S.C. 3 PER CENT. NICKEL STEEL.

1. Description.

The class of steel specified below shall be referred to as :—

E.S.C. 3 per cent. Nickel Steel.

2. Chemical Composition.

Carbon	0·25 to 0·35	per cent.
Silicon	not over 0·30	,,
Manganese	0·35 to 0·75	,,
Sulphur	not over 0·04	,,
Phosphorus	,, 0·04	,,
Nickel	2·75 to 3·50	,

3. Check Test.

When normalised at 840° C. to 880° C., this steel shall pass in every particular the following check test :—

Tensile Breaking Strength	35 to 45	tons per sq. inch.
Yield Ratio	not less than 55	per cent.
Elongation	,, ,, 24	,,
Reduction of Area ...	,, ,, 45	,,

The Brinell Hardness Number corresponding to the above should be approximately 140 to 202.

4. Painting before Delivery.

All consignments of the above steel shall, before delivery, be painted :—

Red.

SPECIFICATION

FOR

E.S.C. 1½ PER CENT. NICKEL-CHROME STEEL.

1. Description.

The class of steel specified below shall be referred to as :—

E.S.C. 1½ per cent. Nickel-Chrome Steel.

2. Chemical Composition.

Carbon	... ...	0·25 to 0·35 per cent.
Silicon	... ...	not over 0·30 ,,
Manganese	... ...	0·35 to 0·60 ,,
Sulphur	... ...	not over 0·04 ,,
Phosphorus	... ...	,, 0·04 ,,
Nickel	... ...	1·25 to 1·75 ,,
Chromium	... ...	0·75 ,, 1·25 ,,

3. Check Test.

When oil-hardened from 850° C. and tempered at 600° C., this steel shall pass in every particular the following check test :—

Tensile Breaking Strength	not less than 45 tons per sq. inch.	
Yield Ratio	not less than 70 per cent.	
Elongation	,, ,, 15	,,
Reduction of Area	,, ,, 50	,,

The Brinell Hardness Number corresponding to the above should be approximately 179.

4. Painting before Delivery.

All consignments of the above steel shall, before delivery, be painted :—

Light Blue.

SPECIFICATION
FOR
E.S.C. 3 PER CENT. NICKEL-CHROME STEEL.

1. Description.

The class of steel specified below shall be referred to as :—

E.S.C. 3 per cent. Nickel-Chrome Steel.

2. Chemical Composition.

Carbon	... 0·20 to 0·30 per cent.
Silicon	... not over 0·30 ,,
Manganese	... 0·35 to 0·60 ,,
Sulphur	... not over 0·04 ,,
Phosphorus	... ,, 0·04 ,,
Nickel	... 2·75 to 3·50 ,,
Chromium	... 0·45 ,, 0·75 ,,

3. Check Test.

When oil-hardened from 820° C. and tempered at 600° C., this steel shall pass in every particular the following check test :—

Tensile Breaking Strength	not less than 45 tons per sq. inch.
Yield Ratio	... not less than 75 per cent.
Elongation	... ,, ,, 15 ,,
Reduction of Area ...	... ,, ,, 50 ,,

The Brinell Hardness Number corresponding to the above should be approximately 179.

4. Painting before Delivery.

All consignments of the above steel shall, before delivery, be painted :—

Violet.

SPECIFICATION

FOR

E.S.C. AIR-HARDENING NICKEL-CHROME STEEL.

1. Description.

The class of steel specified below shall be referred to as :-

E.S.C. Air-Hardening Nickel-Chrome Steel.

2. Chemical Composition.

Carbon	... 0·28 to 0·36 per cent.
Silicon...	...not over 0·30 ,,
Manganese	... 0·35 to 0·60 ,,
Sulphur	...not over 0·04 ,,
Phosphorus	... ,, 0·04 ,,
Nickel...	... 3·50 to 4·50 ,,
Chromium	... 1·25 ,, 1·75 ,,

3. Check Test.

A test bar of this steel that has been air-hardened from 820° C. shall pass in every particular the following check test :—

Tensile Breaking Strength not less than 100 tons per sq. inch.

Yield Ratio	... not less than 75 per cent.
Elongation	... ,, 5 ,,
Reduction of Area	,, 13 ,,

The Brinell Hardness Number corresponding to the above should be approximately 418.

The tensile test piece before being air-hardened shall have its parallel portion machined to within ·02 inch of the finished diameter of the test piece and this portion shall, after the test piece has been hardened, be reduced to the required diameter by grinding.

4. Painting before Delivery.

All consignments of the above steel shall, before delivery, be painted :—

Green.

APPENDIX.

FORMS

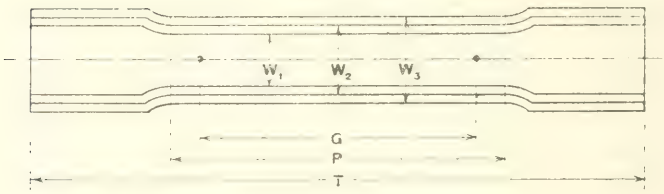
OF

BRITISH STANDARD TENSILE TEST PIECES.

APPENDIX.

FORMS
OF
BRITISH STANDARD TENSILE TEST PIECES.

TEST PIECE **A.**

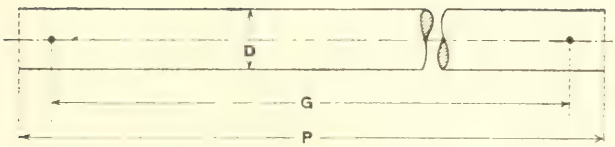


Gauge Length **G** = 8 inches.
Parallel Length **P** to be not less than 9 inches.
Total Length **T** = About 18 inches.

Thickness of Test Piece.	Maximum Width allowed.
Over $\frac{7}{8}$ in. (0·875 in.)	W_1 = $1\frac{1}{2}$ ins.
$\frac{3}{8}$ in. (0·375 in.) to $\frac{7}{8}$ in. (0·875 in.)	W_2 = 2 ins.
Under $\frac{3}{8}$ in. (0·375 in.)	W_3 = $2\frac{1}{2}$ ins.

The widths of the test pieces for plates were selected to comply with the two following conditions. (1) As the great bulk of plates to be tested are from $\frac{3}{8}$ inch to $\frac{7}{8}$ inch thick, it was desirable for the sake of convenience that the test pieces for such plates should be of uniform width, and, in accordance with very general practice, a width of two inches was selected. (2) With a test piece of a given form, the percentage of elongation was found to be less for thick plates than for thin ones; with steel of the same quality in other respects it was desirable therefore to choose widths of test piece which would be slightly in favour of the thicker plates. This is secured with the widths selected for the Standard Test piece of form **A.**

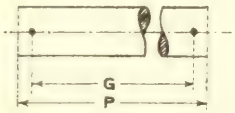
TEST PIECE **B.**



Gauge Length **G** to be not less than 8 times the diameter **D.**
With enlarged ends :—Parallel Length **P** to be not less than 9 times the reduced diameter **D.**

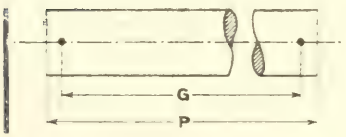
All test pieces of form **B** are strictly similar, and for the same material give the same percentage of elongation. They are nearly similar to a test piece of form **A,** 8 inches in gauge length, 2 inches wide and $\frac{3}{8}$ inch thick.

TEST PIECE **C.**



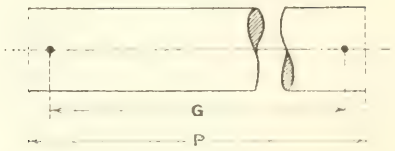
Gauge Length **G** = 2 inches.
Parallel Length **P** to be not less than $2\frac{1}{4}$ inches.
Dia. = 0·564 inch.
Area = $\frac{1}{4}$ sq. inch.

TEST PIECE **D.**



Gauge Length **G** = 3 inches.
Parallel Length **P** to be not less than $3\frac{3}{8}$ inches.
Dia. = 0·798 inch.
Area = $\frac{1}{2}$ sq. inch.

TEST PIECE **E.**

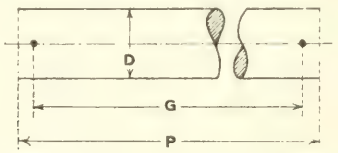


Gauge Length **G** = $3\frac{1}{2}$ inches.
Parallel Length **P** to be not less than 4 inches.
Dia. = 0·977 inch.
Area = $\frac{3}{4}$ sq. inch.

Test Pieces **C, D,** and **E** were arranged to meet the very common practice of making test pieces for forgings, axles, tyres, etc., of either $\frac{1}{4}$ square inch or $\frac{1}{2}$ square inch in sectional area. With the gauge lengths decided upon, these three forms are very nearly similar, and, for a given material, give very approximately the same percentage of elongation. Though not exactly, they are approximately similar to the Standard Test Piece **F,** and for the same material give a nearly identical, but slightly greater, percentage of elongation.

TEST PIECE **F.**

(For Test Pieces over 1 inch diameter.)



Gauge Length **G** to be not less than 4 times the diameter **D.**
With enlarged ends :—Parallel Length **P** to be not less than $4\frac{1}{2}$ times the reduced diameter **D.**

In some testing machines it was found inconvenient to use orm **B** for bars of over 1 inch in diameter, and form **F** of half the gauge length is designed to meet such cases. For a given material the percentage of elongation with test piece **F** is greater than with test piece **B,** and this difference is provided for in the British Standard Specifications.

FORM OF ENDS.

In the case of the round test pieces **B, C, D, E** and **F,** the orm of the ends is to be as required in order to suit the various methods employed for gripping the test piece. When enlarged ends are used the length of the parallel portion of the test piece must in no case be less than that noted on the diagrams.

British Engineering Standards Association.

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MAY, 1919.

(This List cancels all previous Lists.)

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